Space Weather Technical Forecast

Issued on Wednesday, 13 March 2024 at 01:19 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Daily chance of M-flares (R1/R2 Radio Blackouts), reducing into the UTC weekend.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity as recorded by GOES16 and 18 has been low. The peak of these flares was a C3.9 at 12/1135 UTC from the largest and most complex group on the disc, AR3599. This sunspot group showed some continued development in the period, maintaining its delta spot configuration, however foreshortening effects as it approaches the western limb make accurate analysis difficult. There are seven other sunspots on the disc, with AR3606 and AR3607 in the eastern hemisphere continuing to show growth and some magnetic complexity. The rest of the spot regions are small and simple.

There were no observed Earth directed CMEs in the past 24 hours.

Solar Wind / Geomagnetic Activity: Solar wind speeds observed at L1 by ACE were fairly steady between background and slightly elevated levels (380-450km/s). The phi angle was mostly positive (towards the Sun), but did become briefly negative (away from the Sun) at times. The solar wind density was generally below average. The Interplanetary Magnetic Field (IMF), Bt, was stable and small-scale, varying between 2nT to 6nT through the period, with a north-south component, Bz, varying weakly between +6 and -4nT. Geomagnetic activity was Quiet (Kp0-2) through the period.

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux remained at background throughout.

High energy electron flux (greater than 2MeV) observed at GOES16 was mostly at Moderate levels, with a peak of 555pfu at 12/1725UTC. The observed 24-hour fluence showed a steady, then declining trend, with the 24-hour integrated fluence value at 13/0001UTC being 2.51e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: There is a daily Chance of M-class flares, most likely from AR3599. This sunspot is expected to remain on the Earth-facing side until the end of the current UTC working week, whereupon the risk of Moderate activity should fall.

Solar Wind / Geomagnetic Activity: A CME associated with the M7.4 flare from 10 March may pass Earth as a glancing blow later on Day 1 (13 Mar) or perhaps during Day 2 (14 Mar).
Coronal hole fast wind activity is likely to be modest in the period, with a weak connection to CH09/+ possible on Days 1- 2 (13-14 Mar).

All things considered, the geomagnetic forecast should mostly be Quiet to Unsettled with a chance of Active intervals during the first few days, with low confidence of G1/Minor Storm

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intervals should the 10 March M7.4 CME and coronal hole fast stream materialise.

Energetic Particles / Solar Radiation: GOES18 high energy proton flux is expected to persist at background or close to background levels, with a very slight chance of S1 radiation storms, with the main risk from AR3599.

GOES16 high energy electron flux is likely to remain near its current diurnal Moderate oscillation in the near term, with electron counts perhaps seeing a response at GEO upon the passage of the 10 March CME on Days 1-2 (13-14 Mar) however this is deemed low confidence. Hence, 24-hr integrated fluence is likely to remain below the Active threshold.

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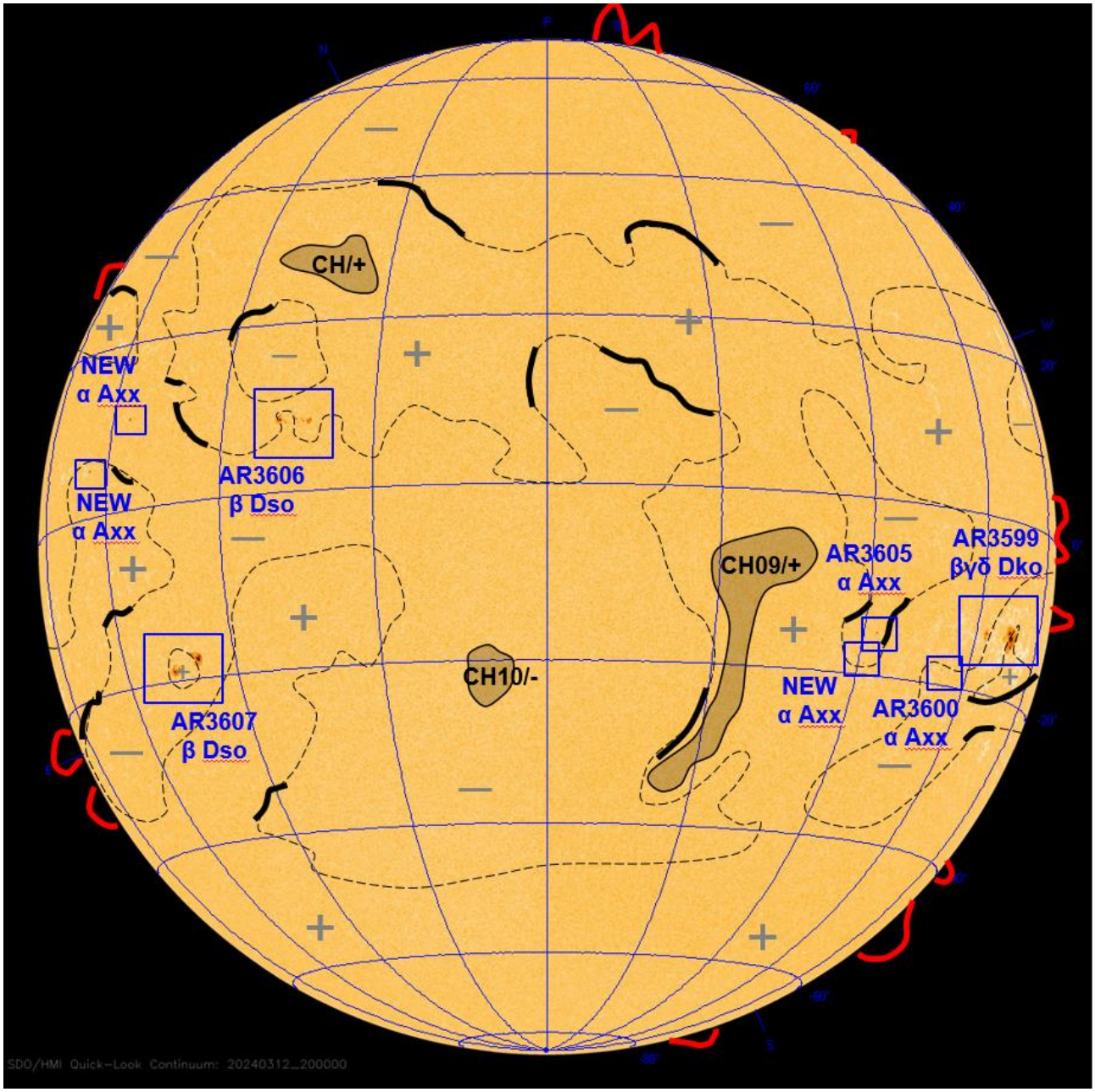
Figure 1. Solar Analysis Valid 12/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There is one CME in the forecast, the M7.4 CME of 10 March, with this signalled to pass largely above and ahead of the track of the Earth in its orbit either late on Day 1 (13 Mar) or early on Day 2 (14 Mar). MOSWOC Enlil and its ensembles suggest there is a slight chance of a glancing blow as it passes Earth, albeit with low confidence.

A filament liftoff was observed on GONG imagery in the southwest quadrant of the visible disc, near to the AR3599 region. This liftoff looks largely to have been re-absorbed, with no CME visible on available coronagraph imagery either. This will continue to be monitored as and when further imagery becomes available.

The fast wind aspect of the forecast is also of relatively low confidence, with none of the current cohort of coronal holes particularly well-formed or having strong links to previous rotations. A connection from CH09/+ may occur through Days 1-2 (13-14 Mar), possibly combining with any CME arrival, however as this coronal hole is of a positive polarity it does not lend itself to producing a strong connection given the time of year and hence should have limited effects. A small negative polarity coronal hole, CH10/- may come into effect later on Day 4 (16 Mar) but this is low confidence at this point.

Mostly Quiet to Unsettled conditions are therefore expected over the next few days, with a slight chance of Active/Minor Geomagnetic Storm G1 on Day 2 should the 10 Mar CME and possible coronal hole fast stream materialise.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	No	5	10	5	1
Strong	**G3**	No	1	1	1	1
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
11/0145 UTC	Partial	M7.4 from AR3599	NW quadrant	300 km/s	14/0000 UTC	Glancing blow, low confidence.

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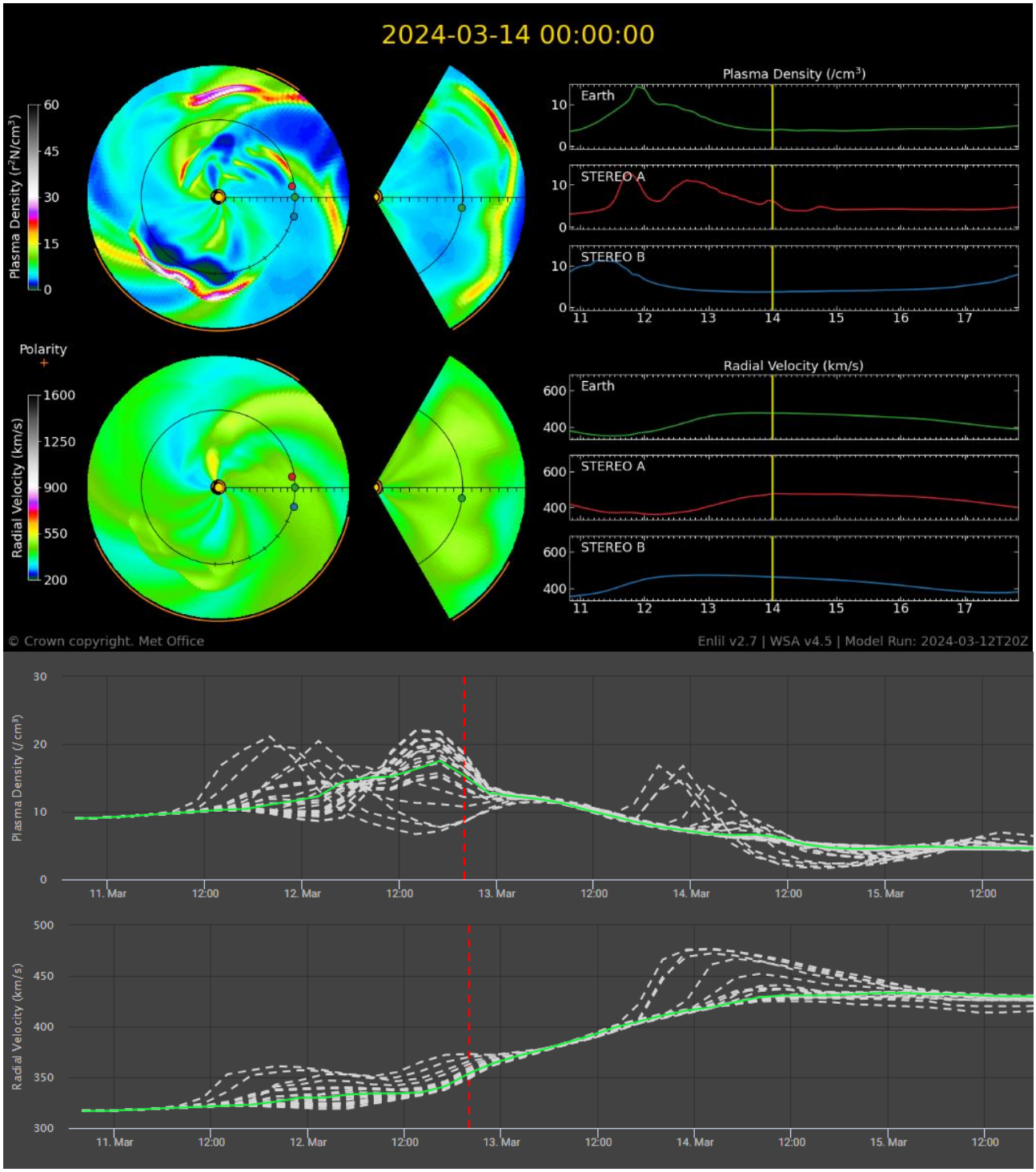
Figure 2: MOSWOC Enlil and ensembles showing possible CME glancing blow early 14 Mar.



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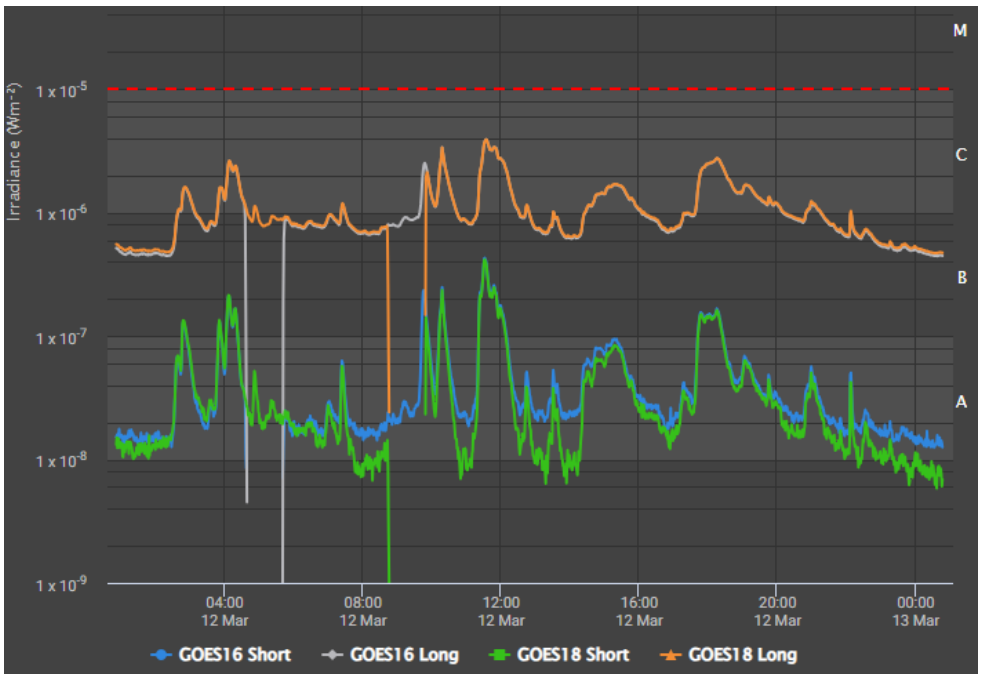
Radio Blackouts - X-Ray Flares:
There are five numbered regions and three as yet unnumbered regions on the visible disc, with AR3602 fading from view. AR3599 remains by far the largest and most complex group, with leading penumbra merging into one larger spot. it remains a delta region, now classified as Dko/beta-gamma-delta, but analysis is becoming increasingly difficult as foreshortening effects come into play as it approaches the western limb. AR3606 and AR3607, both in the eastern hemisphere, have continued to grow with intermediate spots waxing and waning, but have remained quiet. Both regions will continue to be monitored for further growth/development. The rest of the spots on the visible disc are small and simple.

The X-ray flare forecast for the coming days mainly comes from the AR3599 sunspot region, and its passage around the western limb which is expected in the coming days. There remains a Chance of M-class flares, mainly from this region, with the risk then diminishing as it rotates around the limb. No significant returning regions are expected, albeit there may be a more active region rotating around the southeastern in the next few days, with magnetic looping and minor flare activity visible in imagery.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	30	30	20	20
Very Active	R3 to R5 X Class	No	5	5	1	1

Figure 3: GOES16 & 18 X-ray flux.



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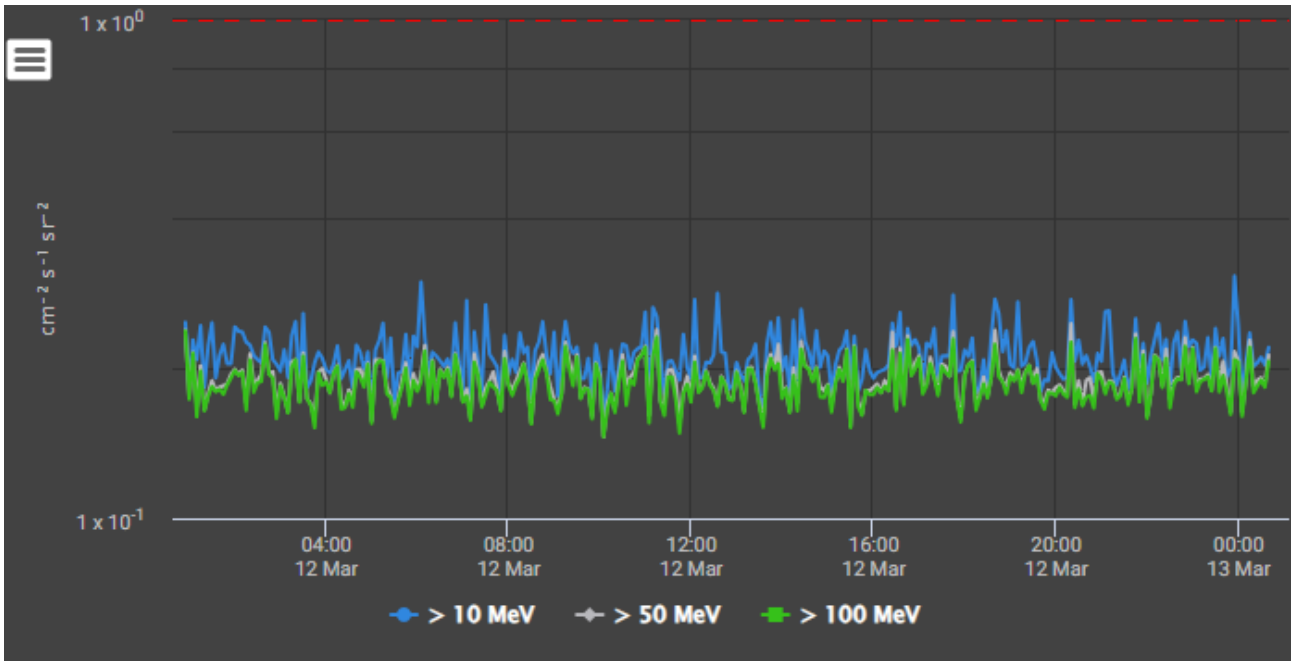
Solar Radiation Storms - (High Energy Protons):
GOES18 proton flux levels are very closely tied to developments in AR3599, with no other sunspot groups of note. This feature proved capable of a very slight enhancement at GOES18 on 10 March in the wake of the M7.4 flare. The risk of S1+ therefore remains through the period as AR3599 advances to the western limb and slightly beyond in the coming four days.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	5	5	5	5
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: GOES 18 Proton flux.



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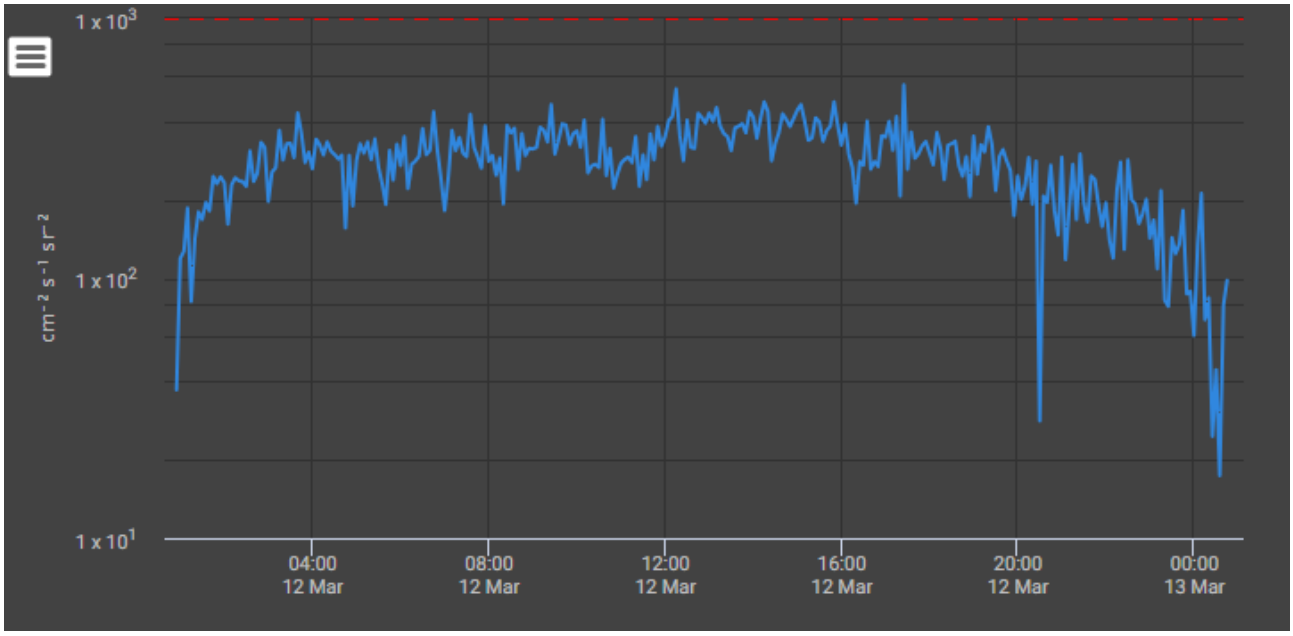
High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) has shown a slight reaction to the recent CH07/- fast wind with flux levels reaching diurnal Moderate levels.

Further response of the electron belt could occur upon the possible passage of the 10 Mar CME arrival as well as CH09/+ coming into play, but both of these features are low confidence and are expected to have low impacts, hence any electron response is deemed unlikely. As a result, 24-hr integrated fluence is likely to remain below the Active threshold with only a slight chance of reaching this should the CME/coronal hole fast stream arrivals occur.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	10	10	5
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: GOES16 Electron flux.



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